California Department of Health Services
Marine Biotoxin Monitoring Program

2004 Annual Mussel Quarantine

BACKGROUND INFORMATION

This information is provided for the preparation of press releases, answering inquiries from the public, and other purposes related to shellfish poisoning and the annual mussel quarantine. Questions and requests for additional information may be directed to the California Department of Health Services (DHS), Environmental Management Branch [Gregg W. Langlois, Coordinator, Marine Biotoxin Monitoring Program, at (510) 412-4635], or the Division of Communicable Disease Control [S. Benson Werner, M.D., Chief, Disease Investigations Section, at (510) 540-2566].

Introduction

The annual quarantine on sport-harvested mussels is in effect from April 23 through October 31. The annual mussel quarantine applies to the entire coastline of California, including all bays, inlets and harbors. The main purpose of the quarantine is to protect the public from the toxins that cause paralytic shellfish poisoning (PSP) and domoic acid. Both of these toxins can occur in bivalve (two-shelled) mollusks, such as mussels, clams, cockles, oysters and scallops, which feed by filtering tiny particles from the water. In addition, domoic acid has been found at levels of concern in the viscera of anchovies and sardines and in the digestive gland of crabs and lobsters.

The mussel quarantine restrictions and recommendations apply only to shellfish collected by sport harvesters. Mussels and other bivalve mollusks harvested by state-certified shellfish growers and sold commercially in markets and restaurants should pose no risk of poisoning to consumers. Since the PSP outbreak in 1980 included illnesses from consumption of commercially harvested oysters, commercial shellfish producers have been required to submit specimens weekly from all commercial harvest areas for PSP analysis by DHS. Bivalve mollusks imported into California are monitored for biotoxins by producer states.

Shellfish toxin levels do not rise and fall in predictable cycles and can increase rapidly. Prevention of human illnesses requires strict enforcement of the annual quarantine, combined with year-round surveillance, public education, and occasional special quarantines and commercial closures as needed.

Paralytic Shellfish Poisoning (PSP)

The Ecology of PSP

The source of the PSP toxin in bivalve mollusks is a dinoflagellate known as *Alexandrium catenella*. These and other phytoplankton (single-celled plants), which are food for filter-feeding shellfish, may proliferate rapidly or "bloom". Under environmental conditions especially favorable

for the occurrence of *Alexandrium* blooms, the shellfish can develop extremely hazardous levels of toxin within a few days without any visible warning. Only occasionally does a dangerous bloom of *Alexandrium* tinge the ocean waters a reddish-brown (the so-called "red tide"). Other phytoplankton species not toxic to humans more commonly cause the red tides seen in California waters. Abalone, crab, or shrimp have not been the source of any cases of PSP in California.

In California, PSP occurs most commonly during the warm spring, summer, and early fall months, although episodes of high toxicity in shellfish have occurred during the winter months also. Since PSP was made a reportable disease in 1927, 521 cases and 32 deaths have been reported to DHS. Over 99 percent of these cases have occurred during the months of May through October. The last major PSP outbreak in California occurred in July 1980 with 98 cases and 2 deaths. In August 1991, 11 non-fatal cases, including 3 that were hospitalized, were reported in persons who had eaten mussels they had collected in northern Sonoma County.

PSP in 2003

The distribution of PSP toxicity in 2003 was greater than observed in 2002, however the magnitude of toxicity was approximately the same. Measurable concentrations of PSP toxins were found in shellfish from the following coastal counties: Del Norte, Humboldt, Mendocino, Sonoma, Marin, San Francisco, San Mateo, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Los Angeles.

Low levels of PSP toxins were detected along the coast as early as February, and persisted through December in several areas. PSP toxin concentrations at or above the alert level of 80 micrograms (μg) per 100 grams of shellfish meat were detected in 19 of the 202 positive samples (9%) from four counties: Humboldt (1), Mendocino (3), Sonoma (2), and Marin (13) counties.

Humboldt County experienced low level PSP toxicity from mid-July through mid-November, with a slight increase to 81 ug in late August. Mussel samples from Mendocino County contained measurable toxicity from mid-August through mid-November, with a peak of 1600 ug on September 29. Measurable PSP toxicity was not detected along the Sonoma County coast until late September, persisting through mid-November with a peak concentration of 110 ug in late September. Shellfish samples from Marin County contained measurable PSP toxicity from mid-February through late December, with concentrations exceeding the alert level from late October through early November and a peak of 334 ug on October 29. Low level toxicity also persisted in Santa Cruz County and San Mateo County through November and December, respectively.

The annual quarantine on the sport harvesting of mussels began as scheduled on May 1. Because elevated toxin levels were detected throughout October, the annual mussel quarantine was extended beyond its normal October 31 termination date, eventually being lifted on November 21. The majority of samples analyzed in 2003 were comprised of mussels, both naturally occurring and cultured, and commercially grown oysters. PSP toxin concentrations above the alert level were detected in both mussels and oysters.

Domoic Acid Poisoning

The Ecology of Domoic Acid

Domoic acid was first recognized as a cause of poisoning in humans in an outbreak in Canada in 1987, when approximately 150 persons became ill and 4 died after consuming toxic mussels from Prince Edward Island on the Canadian Atlantic coast. The source of the domoic acid in this outbreak was a diatom known as *Pseudo-nitzschia pungens* forma *multiseries*. This single-celled marine algae, like dinoflagellates, is a natural food source for filter-feeding animals.

The first documented occurrence of domoic acid on the Pacific coast of the U.S. was in September and October 1991 in the vicinity of Santa Cruz, on Monterey Bay. In this episode it was found to be the cause of death of several hundred brown pelicans and Brandt's cormorants. The birds were exposed to domoic acid by feeding on anchovies, which had fed on the toxin-producing plankton.

Follow-up sampling revealed elevated concentrations of domoic acid in mussels at several locations around Monterey Bay, and elevated levels also were found in razor clams sampled in Humboldt and Del Norte counties. The toxin also has been found at fairly high concentrations in the digestive gland, but not the flesh, of crabs. Low concentrations of domoic acid have been found in mussels from almost every coastal county in California. This toxin has also been detected in oysters at concentrations below the alert level. The high levels of domoic acid in Monterey Bay coincided with a bloom of the diatom *Pseudo-nitzschia australis*, and the toxin also was found in plankton samples.

Similar domoic acid events occurred in May 1998 and in the summer of 2000 along the San Luis Obispo County coast and in Monterey Bay. In 2002 DHS's volunteer phytoplankton observers detected the first signs of what eventually became a massive bloom of *Pseudo-nitzschia*, the diatom that produces domoic acid. This volunteer effort was instrumental in tracking the early stages of this bloom as it first appeared near the Channel Islands and then in Monterey Bay. This was followed by a southward progression of blooms from Santa Cruz through the Los Angeles region, with elevated densities and toxin levels detected from February through May. All of these past events involved illness or death in large numbers of California sea lions and, as in 1991, anchovies and sardines appeared to be responsible for providing a pathway for toxin transport from the diatoms to the marine mammals. Volunteer phytoplankton observers were instrumental in DHS' ability to detect and track these blooms.

Domoic acid also has been found in Oregon and Washington in razor clams, mussels, and crabs. The seasonal patterns of occurrence of this toxin, if such exist, are poorly understood at this time. DHS has detected blooms of this diatom in late winter (February), spring (March through May), Summer (July through August), and in the fall (September through November).

Domoic Acid Poisoning in 2003

Domoic acid poisoning in humans has not been recognized or reported in California. Extensive phytoplankton sampling is being conducted to investigate the spatial and temporal distribution of the diatoms associated with domoic acid production. Extensive blooms of the diatoms that produce domoic acid have been detected and followed along most coastal counties since this program began. These environmental observations provide an early warning to potentially toxic blooms, allowing DHS to respond quickly with intensified sampling and toxin analysis in the

affected area.

The distribution and magnitude of *Pseudo-nitzschia* blooms and the resultant domoic acid toxicity was reduced from the events of 2002. However widespread blooms and toxicity occurred both in Southern California and in Monterey Bay in the spring and fall of 2003. Volunteer sampling efforts in Santa Cruz and Monterey resulted in the detection of an increase in the relative abundance of *Pseudo-nitzschia* by the first week of February, continuing through March and April at sites inside Monterey Bay. In addition, the relative abundance of this diatom increased at sampling sites in Marin and San Mateo counties. The initial observations of increased toxic diatom concentrations prompted the analysis of shellfish samples for domoic acid. Elevated concentrations of domoic acid were detected in mussels from Santa Cruz during March and April. Researchers from U.C. Santa Cruz reported continued high densities of *Pseudo-nitzschia australis* from March through early April, with densities decreasing by mid-April through the end of the month. Concentrations of this toxin decreased by mid April at this site.

There was a dramatic increase in the distribution and relative abundance of *Pseudo-nitzschia* along the Southern California coast during April and May. There appeared to be a northward progression over time in the detection of low concentrations of domoic acid in shellfish, first in Los Angeles at the beginning of April, then Santa Barbara and finally San Luis Obispo by the end of April. The concentration of domoic acid followed the pattern of increase observed for *Pseudo-nitzschia*, increasing through the first three weeks of May at sites along the Santa Barbara coast. By the second week the concentration of this toxin in mussels had increased well above the federal alert level of 20 ppm at Goleta Pier (76 ppm), at an offshore oil platform (92 ppm), and farther south at Long Beach (24 ppm) and Alamitos Bay (22 ppm) in Los Angeles County. Concentrations below the alert level were also detected as far south as Newport Beach Pier in Orange County. During the third week of May the concentration of domoic acid increased at two offshore locations in Santa Barbara, with a mussel sample containing 140 ppm of domoic acid. By the end of May the concentrations of domoic acid had declined significantly in Santa Barbara but persisted at low levels at several sites farther down coast along the Los Angeles and San Diego coastline. Anchovies and sardines fished at various locations along the Southern California coast were collected by the Department's Food and Drug Branch and found to contain high levels of domoic acid.

In response to the observations of increased *Pseudo-nitzschia* numbers, and the resultant increase in domoic acid in May, the Department issued a Health Advisory on May 16 warning consumers not to eat sport-harvested species of bivalve shellfish, sardines and anchovies, or the viscera of sport-harvested or commercially-sold lobster and crab (also known as lobster tomally and crab butter) harvested from the Southern California coast from Santa Barbara through Orange counties.

By September the distribution and relative abundance of *Pseudo-nitzschia* began to increase again along the Southern California coast, but decreased again by the end of the month. High relative abundances of this toxin-producing diatom were also detected inside Monterey Bay in September, and the Department's Food and Drug Branch found high levels of domoic acid in sardines fished from this region. As a result of this increase in *Pseudo-nitzschia* and domoic acid the Department issued a Health Advisory on September 22, warning that consumers should not eat sport-harvested species of sardines, anchovies and bivalve (two-shelled) shellfish from Monterey and Santa Cruz counties bordering Monterey Bay.

The series of toxic blooms detected in 2003 reinforced the value and need for routine monitoring

of phytoplankton populations as an early warning to potentially dangerous blooms that could impact bivalve shellfish, smaller finfish, and, consequently, the people that harvest and consume these resources.

Special Risks from Various Kinds of Bivalve Shellfish

The greatest hazard for PSP and domoic acid poisoning is from the consumption of mussels (see also discussion below on razor clams) because: (1) they concentrate the toxins more quickly and to higher levels than do other shellfish, (2) they generally occur along the open coast where they are directly affected by oceanic blooms, and (3) they are eaten hole without removal of digestive organs.

The consumer cannot distinguish toxic mussels from harmless ones. Moreover, cooking cannot be relied upon to destroy the toxins because they are relatively heat stable. The safest guideline for consumers is as follows: Do not eat mussels taken by recreational sport-harvesters from California coastal waters during the annual quarantine months of May through October. During other months, call the DHS "Shellfish Information Line" at 1-800-553-4133 for a recorded message on the shellfish biotoxin monitoring program and announcements of any special quarantines.

While clams can develop hazardous levels of PSP toxin, they are placed under quarantine only in localized areas when tests reveal the presence of elevated toxin levels in mussels in the vicinity of clam beds or in clams themselves. In clams, the toxin is concentrated primarily in the digestive organs (dark meat), hence, these portions from all types of clams should always be discarded; only the white meat should be eaten.

A special hazard is presented by the Washington or butter clam (*Saxidomus spp*.). They may concentrate the PSP toxin in the neck or siphon (the tube-like part of the clam that sticks out between the shells). It has been found that PSP toxin in the necks of Washington clams may persist for a year or more after an outbreak of PSP.

Northern razor clams (*Siliqua patula*) have been found to present a special risk for domoic acid poisoning because they concentrate domoic acid in the white meat of the foot, a part which normally is preferred for human consumption, and it is suspected they may be able to retain this toxin for extended periods, as the Washington clam retains PSP toxins.

Scallops from California waters may also become toxic. This is true for both the adductor muscles (the "scallop" or white meat that is ordinarily eaten) and the digestive organs (the darkish soft tissue of a scallop left after the white adductor muscle has been removed). In August 1980, a man died of PSP after eating only the digestive organs of a single rock scallop (*Hinnites giganteus*) taken by a sport-diver on the Sonoma County coast. Subsequent investigations revealed that a lower, but still hazardous, concentration of the toxin also may occur in scallop adductor muscles during a PSP episode. The digestive organs of scallops should never be eaten as they may remain toxic year-round. It is unknown how long PSP toxins may persist in the white meat of scallop adductor muscles.

Symptoms of PSP

Eating shellfish that contain PSP toxins leads to an acute disturbance of the nervous system within a few minutes to a few hours. Symptoms begin with tingling and numbness of the lips,

tongue, and fingertips, followed by disturbed balance, lack of muscular coordination, slurred speech and difficulty in swallowing. In severe poisoning, complete muscular paralysis and death from asphyxiation can occur if breathing is not maintained by artificial means. There is no known antidote to the poison. Symptoms tend to resolve entirely in a day or two under proper medical care. Persons who suspect they or others are experiencing PSP symptoms should immediately seek medical treatment.

Symptoms of Domoic Acid Poisoning

Symptoms of domoic acid poisoning can occur within 30 minutes to 24 hours after eating toxic seafood. In mild cases, symptoms may include vomiting, diarrhea, abdominal cramps, headache, and dizziness. These symptoms disappear completely within several days. In severe cases, the victim may experience excessive bronchial secretions, difficulty breathing, confusion, disorientation, cardiovascular instability, seizures, permanent loss of short-term memory, coma, and death. When memory is lost, victims can remember things they knew before they became ill, but remember little that happened after. As with PSP, there is no known antidote and persons experiencing symptoms should receive immediate medical attention.

Groups at Special Risk of Shellfish Poisoning

In recent years, a disproportionate number of PSP cases have occurred in two broad ethnic groups. These include persons from the Philippine community and, more recently, immigrants from Southeast Asia. The high incidence in these two groups probably can be explained by their cultural penchant for mussels and other shellfish as a dietary item, and by their unfamiliarity with the PSP problem, which reportedly is very rare in Southeast Asia. Domoic acid poisoning has never been reported in Asia.

Reporting of Suspected PSP in Humans

PSP and domoic acid poisoning are reportable as food poisoning (Title 17, California Code of Regulations, Sections 2500 and 2574). Even suspected cases should be reported immediately by telephone to the local health department and to the nearest poison control center. Local health departments report PSP cases immediately to DHS' Division of Communicable Disease Control [days, (510) 540-2566, nights and weekends, (510) 540-2308].

Infectious Disease Hazards

Bivalve shellfish should never be taken from waters contaminated by sewage or other pollutants because they also can concentrate disease-producing bacteria and enteroviruses, such as Hepatitis A virus, in their digestive organs.

Public Information Available

The Environmental Management Branch maintains a toll-free "Shellfish Information Line" with recorded updates on shellfish biotoxins and quarantines at 1-800-553-4133. An information leaflet entitled "Natural Marine Toxins" is produced by the University of California Cooperative Extension and DHS. This leaflet is available from both agencies upon request. Press releases are prepared by DHS to announce all annual and special shellfish quarantines.

Other Background Material Available

Quarterly reports issued by DHS are available that include monthly summary information and maps of PSP toxicity and toxigenic phytoplankton distributions along the coast. In addition, a DHS report entitled "California Paralytic Shellfish Poisoning Prevention Program, 1927-1989", by Douglas W. Price, Ph.D., and Kenneth W. Kizer, M.D., M.P.H. (This report, with minor changes, was published as Price et al, 1991.) It reviews the State's experience with PSP from 1927 (when PSP became a reportable disease in California) to 1989, including frequency, seasonal occurrence, geography, dynamics, and other aspects of toxic dinoflagellate blooms, and the development of the PSP prevention program, with an assessment of its effectiveness. Copies are available from the Department of Health Services, Environmental Management Branch, 850 Marina Bay Parkway, #G165, Richmond, CA 94804; telephone (510) 412-4635.

Past copies of monthly, quarterly, and annual reports of the Marine Biotoxin Monitoring Program can be obtained at the following DHS web site:

http://www.dhs.ca.gov/ps/ddwem/environmental/Shellfish/Shellfish.htm

References

Foodborne Poisoning. Paralytic Shellfish Poisoning (Mussel Poisoning). IN: Control of Communicable Diseases in California. 1983. California Department of Health Services. pp. 190-193.

Price, D.W.; Kizer, K.W. & Hansgen, K.H. 1991. California's paralytic shellfish poisoning prevention program, 1927-89. J. Shellfish Res. 10(1): 119-145.

California Department of Health Services, 2003. Marine Biotoxin Monitoring Program Monthly Reports, January through September 2003.